

The Influence of Farmers' Mental Models on an Agroforestry Extension Program in the Philippines

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Abstract The influence of farmers' mental models on the success of an agroforestry extension program on Leyte Island in the Philippines was investigated. Knowledge of farmers' mental models and hence the likely acceptance of technology was used to inform the design of a hypothetically expanded program. To gain an insight into the reasons behind differing acceptance of extension assistance, data were collected and analysed from formal interviews, translated conversations and visual observations. The data provided a chain of evidence and triangulation between farmers' stated intentions and their actions. Farmers had little prior knowledge of nursery technology and were highly receptive to extension assistance which enabled them to develop high self-efficacy in seedling production. However, farmers' rejection of silvicultural advice to thin and prune existing plantations was predicated by existing attitudes to forest resource management. Farmers also expressed a strong preference for a low-cost and low-input approach to establishing timber trees. Visual observations of farmers' tree establishment practices indicated the existence of gaps in their knowledge of tree growth processes. This investigation illustrates the need to elicit farmers' mental models as a parallel enquiry to extension activities. If agroforestry extension is to be constructivist and participatory, accommodation of farmers' mental models and modification of program goals may be necessary. Relatively little is known about the reasons for farmers' acceptance or rejection of silviculture in Leyte and these results indicate that further research into the way that farmers' mental models filter and guide acceptance of advice may be worthwhile.

Keywords Self-efficacy · Constructivist · Question-base approach · Chain of evidence

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Introduction

The failure to adopt agroforestry technology can often be traced to social factors rather than an intrinsic failure of the technology (Bellow et al. 2008). While there have been many studies concerning the effect of farmers' psychological variables on the adoption of agricultural crops, there have been few studies of how these factors influence agroforestry extension (Sood and Mitchell 2004). From a sociological viewpoint, adoption is a mental process based on an individual's perception of technology (Mercer 2004). Hence, for extension program designers, it is almost axiomatic that both farmers' prior experience and their participation in the learning process help them to develop mental constructs, i.e. the traditional 'deep' learning experiences which have a lasting impact.

Seel (2001) defined mental models as cognitive artefacts, i.e. inventions of the mind that represent knowledge in such a way that it becomes plausible. He suggested that in a constructivist¹ viewpoint of learning, mental models guide and regulate human perceptions of the physical and social world. Past experiences are a matter for reflective review (Dewey 1995) and for rural extension, the relevance of farmers' existing mental models is that in the current paradigm, extension workers are facilitators not messengers (Enters and Hagmann 1996) and farmers are participants in the extension process; otherwise, they are still treated as passive acceptors of official wisdom (Röling and Wagemakers 1998; Glendinning et al. 2001). The necessity of understanding farmers' mental models is implicitly recognised in much of the recent extension literature. For example, Franzel et al. (2002) suggested that without knowledge of farmers' perceptions of feasibility and acceptability, agricultural extension is unlikely to succeed. Similarly, an 'actor oriented' extension approach recognises that extension activities may be viewed as arenas in which social actors (e.g. farmers), pursue their own objectives and strategies (Cramb 2000). In Haiti, Murray and Bannister (2004) attributed planning freedoms, particularly in regard to planting and harvesting, as contributing reasons for popular enthusiasm for tree planting. Also, in Kenya, Kiptot et al. (2006) suggested that scaling-up of extension programs is dependent on using farmers as principal agents-of-change. Therefore, extension officers need to understand farmers' mental models or frames of reference, so that they can understand how farmers construe particular issues. Otherwise, farmers' existing mental models may inhibit attempts to introduce technology which is not new, but is new to them.

This paper describes the effect of farmers' mental models on the success of an agroforestry extension program which was undertaken as part of an Australian Centre for International Agricultural Research (ACIAR) project ASEM/2003/052, *Improving Financial Returns to Smallholder Tree Farmers in the Philippines*. During the program, it became apparent that farmers' high acceptance of nursery technology was not matched with acceptance and uptake of advice concerning silviculture in middle-age plantations. The extension program which is described in

¹ For the purposes of this paper, *constructivism* is defined as the process in which learners make a personal interpretation or mental 'construct' of new information, using prior knowledge and experience as a guide.

this paper was designed as a pilot program in circumstances in which little information was available about how, or indeed if, farmers would accept agroforestry extension assistance. Hence, evidence was needed of farmers' mental models to guide the content and delivery of the program. Accordingly, data collection was designed to provide a chain of evidence so that farmers' perceptions of small-scale forestry could be assessed throughout the program. The first focus of this paper is the identification of priorities for silvicultural improvements to small-scale timber plantations in Leyte. The collection of the chain of evidence which assisted analysis of the influence of farmers' mental models on their acceptance of silvicultural technology is then described. Finally, the consequences of farmers' mental models for the delivery of further agroforestry extension activities are examined.

Research Method

The extension program was preceded by a preliminary survey of 81 smallholder timber tree plantations. The findings of the survey indicated that the current level of small-scale forestry in Leyte is low, and the silviculture which has been applied to the plantations is minimal such that the growth and likely commercial value of the plantations is sub-optimal.

To provide technical assistance to farmers, extension activities included visits to demonstration sites, small-group assistance and individual farm visits. As a precursor to the program, a five member expert group comprising technical experts, ACIAR staff and landowners was formed to prioritise silvicultural improvements which would be the focus of assistance. The group met at seven plantations sites and two nurseries and a consensus position was reached on broad recommendations for both nursery and silvicultural improvements which would improve the health and growth of seedlings and trees. These recommendations became the technical basis of the program, with four focal points for assistance: raising seedlings in home nurseries; setting out, planting and establishing trees; thinning defective trees to promote growth of the best stems; and pruning side branches to grow knot-free timber.

Conduct of the Extension Program and Data Collection

The nursery component of the extension program is reported in Baynes and Gregorio (2008) and only a précis of the overall program is presented here. Between 2005 and 2008, the extension program was conducted as case studies in four municipalities on Leyte Island. Farmers were assisted to grow seedlings in home nurseries and establish woodlots of *Swietenia macrophylla* (mahogany). For farmers in the municipalities of Libagon, Dulag, Leyte Leyte and Bato, extension assistance was provided via an introductory field tour and guidance to set up a home nursery. In Libagon and Dulag, farmers were also offered assistance to set out and plant trees. Prior to the field tour, arrangements were made with farmers who already owned plantations to use their farms as demonstration sites where farmers could be

introduced to the four focal points of assistance. Arrangements were also made with Department of Environment Natural Resources (DENR) staff to explain harvesting legislation. The field tours therefore had a dual purpose, first to establish the *bona fides* of the program and extension staff, and second to provide preliminary training and motivation for potential extension participants.

Subsequent to the field tour, farmers were offered small-group or individual assistance to collect seed, start home nurseries, grow seedlings, prepare seeds and out-plant trees. ACIAR extension staff also offered to visit farms where farmers had existing plantations to demonstrate silvicultural pruning and thinning.

Extension staff had been advised that some farmers may join the program either as a complement to program organisers, or to see what material benefits the program may bring. The necessity for diplomacy and tact often precluded direct questioning of farmers with limited formal education and social confidence. Hence, data were collected using interviews, conversations and visual observations to provide a chain of evidence. The evidence is presented logically rather than chronologically and, for triangulation, evidence from ancillary training which was undertaken on the neighbouring island of Bohol was also used.

Data Collected Through Interviews

Interview data were collected on three occasions. First, farmers were individually interviewed on the way to the field tour. This interview acted as an 'ice-breaker' which helped to dissipate farmers' initial wariness of outsiders. Data collection was necessarily restricted to the collection of simple demographic information and details of any previous agroforestry training.

Second, having provided farmers with an opportunity to meet the owners of the demonstration sites and to discuss aspects of small-scale forestry with extension staff, an on-farm or home preparatory interview was conducted with 33 farmers and their families. The purpose of the interview was to confirm their desire to join the program, and to identify any impediments to their participation. Because little was known about farmers' requirements or priorities, one part of the interview was conducted as a loosely structured 'mind mapping' exercise in which farmers' comments were written on a sheet of cardboard. The family was asked to write (or have written for them) both positive and negative aspects of tree growing. They were also asked to list and prioritise impediments which they either could or could not overcome by themselves. Perhaps inevitably, most responses were provided by the household head. Responses were then analysed by identifying key phrases or sentences which were then classified into themes which were found to be common to more than one household. For example, the most frequently cited reasons for growing trees were to provide lumber to build a house, for commercial sale, or as a legacy for children. These reasons were classified as two themes, 'commercial or private use' or 'as a legacy'. The incidence of specific themes in the overall cohort of 33 farmers was then used to identify impediments to the delivery of the program and as a guide to the importance of specific extension activities.

The final interview was undertaken at the end of the project. Extension staff considered that the level of rapport between farmers and themselves was such that

farmers could be asked to provide honest evaluations of the program. In semi-structured interviews, farmers were asked to list and describe the strengths and weaknesses of the program and any aspects which should be changed. Hence, typical interview questions included:

- 'What advice would you give to ACIAR to improve the program'?
- 'If you were trying to invite farmers to a field tour, how would you ensure that farmers received the invitations'?

Because at this stage of the program farmers had learnt to trust extension staff, most responded in an open and frank manner.

Data Collected Through Translated Conversations

The second source of data comprised conversations between farmers and extension staff during farm visits and field training. With farmers' permission, extension staff recorded conversations and then translated and transcribed them into English. The correct meaning of translations was checked by a Filipino colleague and relevant statements of intent, attitude or self-efficacy were extracted and thematically coded, as described above. Although much of the conversations comprised social chit-chat, the translated conversations provided evidence of the thinking of both individual farmers and participating farmers overall. In a similar manner to the use of the interview data, analysed conversations were used to identify farmers' acceptance or rejection of silvicultural techniques.

Data Collected by Visual Observation

A final source of data was provided by visual observation of what farmers actually did. Because some silvicultural techniques had been presented as optional improvements, visual observations were used to compare farmers' actions with advice which had been offered. For example, for tree establishment on flat terrain, ploughing was presented as a more expensive but more effective option to the traditional site preparation technique of slashing grass.

Extension staff observed whether farmers acted on advice and the degree to which suggestions were implemented. They inspected nurseries and planting sites and noted whether farmers purchased fertiliser, fungicide or other inputs which may have indicated their degree of commitment. Visual observations therefore provided direct corroboration (or rebuttal) of farmers' stated intentions and actions.

Insights into Farmers' Mental Models and Acceptance or Rejection of Technology

Responses to the initial interview indicated that farmers in all four municipalities belonged to a broadly similar socio-economic cohort. The age of the farmers ranged from 47 to 55 years and 43% of them had part-time employment or were semi-retired. Only 26% of farmers claimed to understand the requirements of tree registration

Table 1 Examples of themed responses to a question concerning families' reasons for planting trees

Farmers responses to theme: 'as a legacy'	Farmers responses to theme: 'for commercial use'
If I have a grandson, he can harvest them in the future	For housing or if there is a buyer, we can sell the trees
For our children, so they can inherit the trees	They can be used as a source of income
So that my son can afford to send his children to school	It will only take 10 years and then we can harvest them

legislation and virtually none had received forestry training. Many farmers owned several small parcels of land and coconuts were the main farm crop. Invariably, their interest in tree growing had been sparked by their inability to utilise fully one or more of their small parcels of land. The interview provided little insight into farmers' mental models of timber tree growing, other than that they had little understanding of silvicultural techniques, harvesting legislation or transport approvals.

In the second interview, some families took over an hour to record their perceptions of the difficulties associated with growing and managing timber trees. Several families asked to be photographed listing the difficulties and it was apparent to extension staff that this represented a sign of commitment to the program. Their responses were simplified into two broad themes, as reported in Table 1, to provide evidence of their overall perceptions and motivations (Table 1). Overall, almost all responses described commercial sale or domestic use of trees as equally important options, but 64% of the 33 families also cited environmental reasons, principally soil conservation and enrichment through leaf organic matter. Families accepted that tree growing is a long-term process, with 61% of them indicating that the trees would be planted as a legacy for their children.

The main inhibitions to tree planting were the danger of trees being grazed or burnt (almost all responses) and the cost of purchasing seedlings and establishing trees (39%). Problems which farmers could not overcome were a lack of technical knowledge (67% of responses) and the cost of planting materials (70%). After the talk by DENR officers, only 15% of farmers perceived tree registration to be a serious impediment, but their reasons appeared to be heartfelt, e.g. 'I already have trees but I'm afraid to cut them because of prison.'² Overall, the second interview indicated that after the field day, farmers had a broad mental picture of nursery management and tree growing which could be developed further

Farmers' Acceptance of Nursery Technology and Their Development of a New Mental Model

In Libagon and Dulag, few of the 22 participating farmers had experience of growing seedlings and they readily accepted assistance to raise seedlings in home nurseries. They were assisted to collect seed, prepare potting medium, and

² The fear of fines and imprisonment for offences related to tree cutting are often expressed by farmers in the Philippines as an impediment to growing and selling timber trees.

germinate seedlings. Unfortunately, persistent rain caused seedling containers to become waterlogged and fungal disease spread through entire batches of seedlings. Translated comments (e.g. 'so it seems that my seedlings are a failure') indicated that farmers' confidence in their ability to raise seedlings was low and as a consequence, the entire program was also in danger of collapse.

Remedial training was highly successful in inducing farmers to separate, elevate and ventilate seedlings to encourage air circulation and restrict transmission of fungal spores. With encouragement, farmers persisted and eventually 86% of them successfully raised and out-planted seedlings. In addition, their comments indicated that they had developed a high level of self-efficacy³ to raise seedlings and establish trees in the future. These comments, e.g. 'yes I have experimented, these are cuttings and they are growing already', were indicative of a positive mental model of nursery and tree establishment techniques.

The Influence of Farmers' Prior Mental Models on Their Rejection of Extension Assistance

Despite farmers' high acceptance of nursery technology, it became apparent that they had little enthusiasm for thinning and pruning woodlots. At the field day, farmers participated enthusiastically in group exercises to demonstrate silvicultural thinning of overstocked plantations in which weaker trees are removed to promote growth of larger trees. However, translated conversations provided a different impression of the effectiveness of this activity. After finishing the exercise, farmers often responded with a Cebuano idiom 'arang mang sayanga' which may be approximately translated into English as 'but there is still a value' or 'it's such a waste'. The use of the idiom indicated that farmers considered that removing weaker or misshapen trees was undesirable because the trees were still valuable and it was wasteful to remove them. Further translated comments indicated that their mental model of tree utilisation is to log larger trees, as and when they are required, and to let smaller trees grow on. Small trees may be used for firewood and because this commodity is not in short supply in Leyte, it makes more sense to farmers to allow smaller trees to grow until they are needed.

Similarly, pruning demonstrations were not well received by farmers. In these demonstrations tree branches are removed to promote the growth of knot-free timber and branch stubs are cut short. Farmers commented that while a pruning saw or long-handle secateurs may be used in industrial forests, they typically used a machete and they had not observed any ill effects from pruning in this manner. While pruning with a machete may cause fungal infection of branch stubs and poor tree health (Peque 2003), this consequence was not part of farmers' mental model and pruning demonstrations were consequently discontinued.

³ For this paper, self-efficacy is defined as a personal belief that one can perform in a particular manner to achieve an objective.

The Influence of Farmers' Prior Mental Models as a Restriction on Their Acceptance of Advice

Farmers' unwillingness to supply capital or material inputs persisted throughout the program. In the interviews, farmers had initially commented that the expense of growing and establishing trees is a key impediment and this sentiment was reflected both in their actions and in their final evaluation of the program. When fungal infections caused widespread seedling mortality, extension staff offered to demonstrate the use of fungicide provided that farmers purchased it. Not one of 22 farmers purchased fungicide, opting for the more laborious option of discarding diseased seedlings and replacing infected potting mix. Similarly, only 35% planting sites were ploughed, 20% were fenced to prevent grazing, and 7% were fertilised. In addition, 38% of farmers discontinued weed control 1 year after planting, although on some sites, the trees had not achieved release from competition. Except for two relatively wealthy farmers, it was apparent that farmers were willing or able to supply essential labour, but little in the way of capital or materials. In the final interview in which farmers were asked to provide advice for future programs, 59% of their responses indicated that financial assistance was necessary, through the donation of seedlings, fertiliser, fencing materials, labour or cash. Overall, both farmers' words and actions reflected a mental model of a low-cost or low-input approach to raising seedlings and establishing trees.

Unexpected Evidence of Farmers' Mental Models Influencing Program Outcomes

Unexpected evidence of farmers' limited understanding of factors which affect tree growth became apparent during inspections of planting sites. Only 26% of farmers accepted offers of assistance to lay out their plantations and plant their seedlings. Consequently, many sites were not visited until after planting and on these sites farmers had often planted trees directly adjacent (i.e. closer than 1 m) to mature trees or coconuts. When questioned about this practice, several farmers responded that they thought trees should be planted 'within kissing distance' of other trees in order to make them grow straight. Also, on 7% of sites farmers had planted trees underneath a dense canopy in a situation where the seedlings would become suppressed. In both these instances, farmers showed evidence of a simple misconception rather than a well formed mental model of tree growth. In that suppressed trees are unlikely to grow in accord with farmers' expectations the long-term failure of these trees may present a negative image of the extension program.

Discussion, Conclusions and Implications for an Expanded Program

If, as proposed by Eckert and Bell (2005), mental models act as a guide and filter to information, the findings of this investigation suggest that the success of agroforestry extension in Leyte may be contingent on an understanding of how farmers are likely to react to extension assistance. The extension program showed

that farmers had a limited understanding of nursery and tree establishment technology but were receptive to training. Hence, a chain of skills-based activities, from introductory training, setting up a home nursery, collecting seed, growing seedlings and establishing woodlots, provided complementary experiences which were conducive to the development of a positive mental model of tree growing. For nursery and tree establishment skills, farmers' mental models could be described in terms of self-efficacy, first observed as competence in nursery skills and then, as their confidence improved, as spoken comments. For a hypothetically expanded program, this finding suggests that provided appropriate extension assistance is available, the absence of conflicting perceptions of technology may assist the development of positive mental models.

Given farmers' rejection of advice concerning thinning and pruning, extension staff were obliged to question whether their initial approach to later-age silviculture was appropriate. This position is reported by Walters et al. (2005) as the tension between a *discipline-based approach* and a *question-based approach*, the latter fostering questions about why farmers will or will not adopt technology. In this extension program, a participatory, constructivist approach to extension activities dictated that farmers' viewpoints be accepted. Hence, as more was discovered about farmers' mental models throughout the program, the focus of extension activities was necessarily shifted away from middle-age silviculture to nursery and tree establishment. While the technological basis for thinning and pruning timber trees is well established, farmers did not perceive these techniques to be applicable to their circumstances. In the neighbouring island of Bohol, farmer's mental model of thinning has been reported by Yeo et al. (2005) as a legacy of other extension work in which farmers were advised to plant trees at close spacing because planting more trees was deemed to be equivalent to producing more wood. In this program it became obvious that farmer's mental model of thinning and pruning was firmly held and it may have been pointless and even inappropriate to try to impose different thinking.

Extension staff may not have become aware of farmers' perceptions if casual conversations had not been recorded and analysed. For an expanded program, these results suggest that a parallel questions-based enquiry may be a worthwhile addition to extension activities. Similarly, farmers' initial comments that a main purpose of tree planting is to reduce erosion and supply leaf organic matter to the soil, suggested that their mental model is different to the industrial-forest approach of optimising tree growth through cultivation, weed control and fertilising. If farmers' mental models include growing trees to improve the soil, rather than improving soil fertility to optimise tree growth, then it becomes less logical for them to supply expensive inputs. Smallholder farmers in developing countries are riddled with insecurities (Heim 1990) and it may be unrealistic to expect them to embrace anything but low-cost technology.

Because some of the farmers who planted trees in this program could be expected to become farmer-champions in an expanded program, their mental models may become key determinants of program success. Ideally, the technology provided by program designers would be compatible with these mental models. However, as in this situation, if farmers have an existing mental model which is at variance from the

technology envisaged by program designers, a constructivist approach may be needed which allows for multiple interpretations and varying levels of adoption.

These results do not suggest that a commitment to a constructivist or participatory approach is misplaced. Use of participatory techniques and incorporation of traditional knowledge is strongly linked to agroforestry adoption and farmer-led innovation (e.g. see Fischer and Vasseur 2002; Katanga et al. 2007). This investigation reveals that without knowledge of farmers' mental models, program-led innovations may fail. For extension program designers, this suggests that efforts to ascertain and monitor these models may be well worthwhile.

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